HABITAT PREFERENCE AND ENVIRONMENTAL RELATIONS OF *HYDROBIA* SP., MOLLUSCA: GASTROPODA, IN THE INTERTIDAL SUBSOIL OF A TROPICAL MANGROVE REGION[1]

R. SUNIL KUMAR[2]

(*With one text-figure*)

Key words: Mangrove, subsoil, ecology, estuary, intertidal area

Ecological distribution and pattern in population density of *Hydrobia* sp., a mud snail, both horizontally and vertically in the subsoil, is described in detail from intertidal areas of a tropical estuarine habitat. A maximum monthly density of 306/0.1 sq. m was recorded. Total density recorded was 281/0.1 sq. m at location 1 and 1,811/0.1 sq. m at location 2. The varying distribution and abundance among the two mangrove regions studied was noted. This variation may be correlated with the difference in texture and nature of the mangrove substratum. The drastic change of ecological factors, especially salinity, does not seem to influence the occurrence, showing the species' typical euryhaline behaviour. Maximum occurrence and density of this species was seen in the top 0-5 cm sediment stratum and apparently decreased towards the deeper part. High abundance of mangrove detritus is the cardinal factor favouring the habitat selection of the species. Its adaptability to the peculiar dynamic mangrove system helps its survival there.

INTRODUCTION

A variety of benthic organisms occupy the intertidal habitat of the tropical and subtropical mangrove regions of the world. The molluscan taxa form an important group among these benthic organisms (Kasinathan and Shanmugam 1985; Patra *et al.* 1990; Singh and Choudhury 1995; Alcantara and Weiss 1995; Schrijvers *et al.* 1995; Sheridan 1997; Yu *et al.* 1997; Sunil Kumar 1997, 1998). Molluscs are distributed in the topsoil as well as in the subsoil, and also as epibionts, attached to the submerged roots, timber and branches of mangrove vegetation. The present study describes the horizontal and vertical distribution pattern, ecological distribution and population structure of the mud snail *Hydrobia* sp. in the intertidal subsoil of Cochin mangroves in Kerala. The occurrence of *Hydrobia* sp. in the mangrove ecosystem of Cochin backwaters is being reported as a new record to the mangrove habitat of the Indo-Pacific region (Sunil Kumar 2001).

MATERIAL AND METHODS

Two fringing mangrove areas of Cochin backwaters, represented by the dominant mangals *Rhizophora mucronata* and *Avicennia officinalis* were selected for field collection. Monthly collections were taken for two years from September, 1989 to August 1991 from the intertidal area, namely low tide, mid tide and high tide regions. Triplicate soil samples, using a box corer (120 sq. cm), were made during the low tide period of the tidal cycle from the top 20 cm of the mangrove substratum. From this, the upper 15 cm length sample was taken for study. Collections from each tidal area were pooled and sieved through a 0.5 mm mesh sieve to separate the benthic organisms. Organisms were sorted, counted and the population density of *Hydrobia* sp. was determined and is expressed in number per 0.1 sq. m. Sand-silt-clay fractions

[1]Accepted December, 2001
[2]School of Marine Sciences,
Cochin University of Science and Technology,
Cochin 682 016, Kerala, India.
Present Address: Department of Zoology, Catholicate College,
Pathanamthitta 689 645, Kerala, India.

of the soil (Krumbein and Pettijohn 1938) and organic matter (Walkley and Black 1934; El Wakeel and Riley 1957) were determined season-wise. Environmental factors were analysed monthly by standard methods (Strickland and Parsons 1977). For studying the vertical distribution of the species 20 cm sediment core sample were taken and each sample was cut into 0-5, 5-10 and 10-15 cm length. The 16-20 cm depth soil sample was not taken for the analysis. These 5 cm strata from three different depth levels were sieved separately and organisms counted.

Results and Discussion

Environmental factors

Of the various environmental factors studied, salinity fluctuated the most according to seasons; its distribution pattern in two locations is given (Fig. 1). The dissolved oxygen content ranged from 1.61 to 5.4 ml/l and 1.71 to 6.7 ml/1 at locations 1 and 2 respectively. The pH value of the sediment varied from 6.4 to 8.75 at location 1; 6.3 to 8.3 at location 2. The pH value of water ranged from 6.2 to 7.5 and 6.1 to 7.6 at locations 1 and 2 respectively. Sediment temperature varied from 28 to 33 °C at both locations. Water temperature varied from 30 to 33.5 °C at location 1 and 29 to 36 °C at location 2.

The sediment texture showed marked variations in the two study areas (Table 1). In general, sand was dominant, followed by silt and clay. Sediment type was sandy in the three tidal areas in all seasons at location 1. At location 2, it was clayey sand during pre-monsoon and post-monsoon, and silty sand during monsoon. Minor fractions of the sediment (silt, clay) were high at location 2.

The occurrence of *Hydrobia* sp. throughout the study period, despite changing salinity, clearly substantiates the typical euryhaline nature of the species. Varying salinity distribution pattern, and other abiotic factors such as temperature, dissolved oxygen and pH do not appear to affect its occurrence.

Horizontal distribution and population density

Population structure of *Hydrobia* sp. is given in Table 2. Of the two locations, the species showed a regular distribution pattern in location 2. Total density recorded was 281/0.1 sq. m and 1,811/0.1 sq. m at locations 1 and 2 respectively.

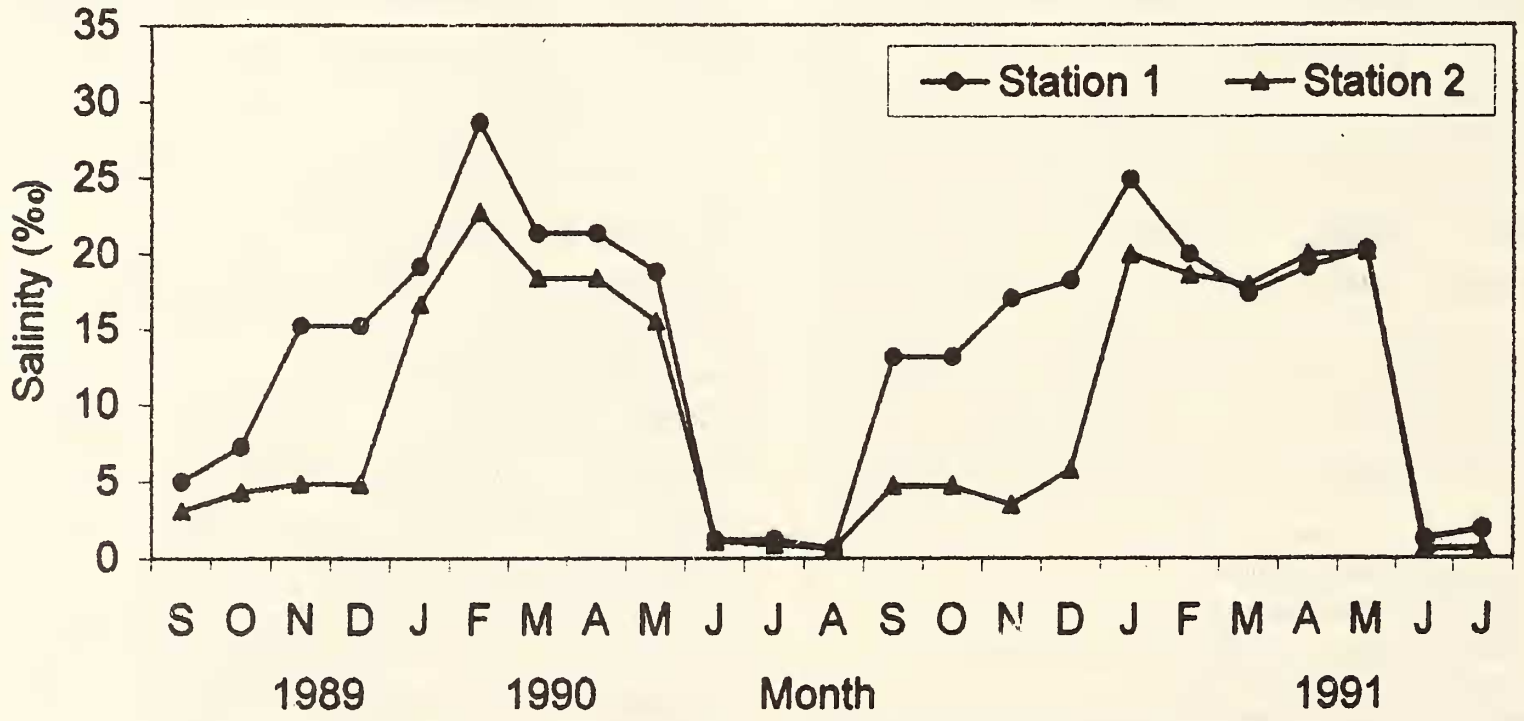

Fig 1: Monthly variation of salinity in the two locations

TABLE 1

SEDIMENT CHARACTERISTICS OF THE STUDY AREA IN DIFFERENT SEASONS (ALL VALUES EXCEPT pH in %)

	Pre-monsoon (February-May)					Monsoon (June-September)					Post-monsoon (October-January)				
	Sand	Silt	Clay	Organic carbon	pH	Sand	Silt	Clay	Organic carbon	pH	Sand	Silt	Clay	Organic carbon	pH
Location 1															
HTL	87.22	10.38	2.4	0.77	6.65	85.86	4.97	9.17	0.45	7.25	88.76	3.31	7.93	0.89	6.4
MTL	88.76	7.62	3.62	0.44	6.8	80.92	11.38	7.7	0.55	7.1	77.24	2.66	20.1	0.81	6.6
LTL	86.34	5.19	8.47	0.42	7.3	85.69	11.56	2.75	0.35	7.25	79.67	9.02	11.31	0.64	6.5
Location 2															
HTL	73.33	11.1	15.57	1.53	6.75	70.4	20.47	9.13	1.44	7.59	64.12	15.04	20.84	1.65	6.3
MTL	69.97	13.49	18.54	2.16	6.63	65.04	19.29	15.67	1.71	6.9	63.75	17.1	19.15	1.82	6.3
LTL	62.37	14.07	23.61	2.35	6.8	47.77	44.28	7.95	2.37	7.4	51.86	12.81	35.33	2.36	6.4

HTL = High tide level, MTL = Mid tide level, LTL = Low tide level

TABLE 2

POPULATION DENSITY (/0.1 SQ. M) OF *HYDROBIA* SP. IN THE LOW, MID AND HIGH TIDE REGIONS OF THE STUDY AREA

Year	1989								1990								1991				
Month	Sept	Oct	Nov	Jan	Feb	Mar	May	Jun	Jul	Aug	Sep	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Location 1																					
Low tide area	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	31	-	-	-	-	8
Mid tide area	17	22	-	-	-	3	8	-	-	11	25	-	-	6	6	8	3	6	-	-	-
High tide area	11	14	6	-	-	-	-	-	-	3	14	3	8	14	11	-	8	8	-	8	11
Location 2																					
Low tide area	25	17	31	19	-	25	56	8	-	3	28	56	33	22	306	19	14	22	94	-	6
Mid tide area	17	22	47	56	6	22	14	42	3	19	28	106	47	106	61	28	3	6	31	-	-
High tide area	-	28	17	33	-	39	56	42	3	31	-	33	19	17	22	11	3	6	-	-	3

Maximum monthly population density of 306/ 0.1 sq. m was recorded in February 1991, followed by 106/0.1 sq. m in November 1990 and January 1991 in location 2. The species showed no seasonal pattern in distribution.

A substantial variation in the distribution of the species was evident in the three tidal areas. At location 1, *Hydrobia* sp. population was 42.4%, 40.9% and 16.7% in the high, mid and low tide areas respectively, while at location 2, the population was 20%, 36.7% and 43.3% in the high, mid, and low tide areas respectively. A reduction in population density from high to low tide areas was thus seen at location 1, as opposed to an increase in population density from high to low tide areas at location 2. The greater numbers of the species in the low tide area of location 2 and high tide area of location 1 indicate that the tidal rhythm does not seem to influence the horizontal distribution and abundance of this infaunal mollusc. This suggests that the little more consolidated substratum of prolonged exposed high tide areas as well as the non-consolidated substratum, when only compared to high tide areas, of prolonged submerged low tide areas simultaneously favoured the occurrence of *Hydrobia* sp. Tidal cycle is a characteristic feature of the intertidal area. The exposed area above the mid-tide mark was more consolidated than the more submerged area of the low-tide mark. Therefore, the nature of the substratum apparently varies in the intertidal zone. *Hydrobia* sp. was distributed irrespective of the substratum.

Vertical distribution

The vertical distribution of *Hydrobia* sp. at location 2 is given in Table 3. Maximum density was found in the upper 0-5 cm sediment stratum. 63.3%, 15.1 % and 21.6% of the fauna was found at 0-5, 5-10 and 10-15 cm respectively. A maximum of 50/0.1 sq. m (in June, 1991) and 19/0.1 sq. m (in March, 1991) *Hydrobia* sp. were recorded in the deeper 10-15 cm stratum in comparison to the upper stratum of mangrove soil. Vertical distribution pattern of *Hydrobia* sp. reveals that the species can penetrate the soil down to 15 cm and beyond, showing its burrowing ability. High numerical abundance of the organisms in the 10-15 cm depth in comparison to the topsoil, only in two months (Table 3) and also its lower density at other periods of the study in deeper portion shows the capacity of *Hydrobia* sp. to survive in the deeper mangrove soil. Availability of detritus formation appears to be more pronounced in the surface sediment strata and this may coincide with the maximum abundance of species in the 0-5 cm sediment layer.

Hydrobia ulvae is a detritus- and deposit-feeder, and the difference in abundance of the species can be attributed to the nature of substratum in which they live (Newell 1965). It is suggested that the feeding habits increase with finer fractions of sediment. In the present study, the intertidal soil of the two mangrove areas was rich and thoroughly mixed with enormous detritus, while the substratum showed a characteristic difference in sand-silt-clay fractions. Finer fractions (silt and clay) of sediment and organic carbon were high at location 2, compared to location 1 and *Hydrobia* sp. showed dominance in the former area. Moreover, the concentration of organic carbon content pertains largely to the finer fractions of sediments (Sunil Kumar 1996). Food resource input as well as other ecological features of mangroves might be more or less similar in these two areas, whereas the mangrove substratum showed variability, reflecting the difference in distribution and numerical abundance of species.

Tidal influence, a cardinal factor as far as the distribution of various intertidal animals in different habitats is concerned, did not appear to be a limiting factor in the distribution of *Hydrobia* sp. in the present study. High abundance of detritus, the favourite food of *Hydrobia* sp., together with its euryhaline nature,

TABLE 3
POPULATION DENSITY (/0.1 SQ. M) OF *HYDROBIA* SP. IN THREE STRATA (0-5, 5-10, 10-15 CM) AT LOCATION 2

	Low tide area			Mid tide area			High tide area		
	0-5	5-10	10-15	0-5	5-10	10-15	0-5	5-10	10-15
March 1990	25	-	-	14	-	8	36	-	3
June	6	3	-	25	8	8	28	11	3
September	22	3	3	22	3	3	-	-	-
January 1991	11	8	3	92	11	3	6	6	6
March	17	3	-	3	6	19	6	-	6
June	22	22	50	22	3	6	-	-	-
August	6	-	-	-	-	-	-	-	3
Total	109	39	56	178	31	47	76	17	21

burrowing capacity and adaptations for survival towards deeper sediments are favourable factors responsible for the long-term occurrence and abundance of organisms in two different types of substrata. The study also reveals that *Hydrobia* sp. prefer the mangrove habitat of location 2, of which the top 0-5 cm layer of the soil provides the most suitable habitat.

REFERENCES

ALCANTARA, P.H. & V.S. WEISS (1995): Macrobenthic communities associated with the red mangrove (*Rhizophora mangle*) in Terminos Lagoon, Mexico Gulf. *Rev. Biol. Trop. 43*: 117-129.

EL WAKEEL, S.K. & J.P. RILEY (1957): The determination of organic carbon in marine muds. *J. Cons. Perm. int. Explor. mer. 22*: 180-183.

KASINATHAN, R.A. & SHANMUGHAM (1985): Molluscan fauna of Pichavaram mangroves, Tamil Nadu. *In*: Proceedings of the National Symposium in Biology, Utilisation and Conservation of Mangroves (Ed.: Bhosale, L.J.). Pp. 438-443.

KRUMBEIN, W.C & F.J. PETTIJOHN (1938): Manual of sedimentary petrography. Appleton Century Crofts, New York, pp. 549.

NEWELL, R. (1965): The role of detritus in the nutrition of two marine deposit feeders, the prosobranch *Hydrobia ulvae* and the bivalve *Macoma baithica*. *Proc. Zool. Soc. London 144*: 25-45.

PATRA, K.C., A.B. BHUNIA & A. MITRA (1990): Ecology of macrobenthos in a tidal creek and adjoining mangroves in West Bengal, India. *Envir. Eco. 8(2)*: 539-547.

SCHRIJVERS, J., D. VAN GANSBEKE & M. VINCX (1995): Macrobenthic infauna of mangrove and surrounding beaches at Gazi Bay, Kenya. *Hydrobiologia 306(1)*: 53-66.

SHERIDAN, P. (1997): Benthos of adjacent mangrove, seagrass and non-vegetated habitats Rookery, Florida, U.S.A. *Estuar. Coast. Shelf Sci 44(4)*: 455-469.

SINGH, B.N. & A. CHOUDHURY (1995): Studies on the distribution of Gastropoda (Mollusca) in a mangrove forest (Prentice Island) of Sunderbans, India. *J. mar. biol. Ass. India 37 (1&2)*: 283-286.

STRICKLAND, J.D. & T.R. PARSONS (1977): A practical handbook of sea water analysis. *Bull. Fish. Res. Bd. Canada*, Ottawa, 167, pp. 203.

SUNIL KUMAR, R. (1996): Distribution of organic carbon in the sediments of Cochin mangroves, South West Coast of India. *Indian J. Mar. Sci. 25*: 274-276.

SUNIL KUMAR, R. (1997): Vertical distribution and abundance of soil dwelling macro invertebrates in an estuarine mangrove biotope. *Indian J. Mar. Sci. 26*: 26-30.

SUNIL KUMAR, R. (1998): A critique on the occurrence and distribution of macrozoobenthos in a traditional prawn field and adjacent mangroves in Cochin backwaters. *J. mar. biol. Ass. India 40 (1&2)*: 11-15.

SUNIL KUMAR, R. (2001): New record of the mud snail *Hydrobia* (Mollusca: Gastropoda) from the mangrove habitat of Indo-Pacific region. *J. Bombay nat. Hist. Soc. 98(1)*: 142-144.

WALKLEY, A. & I.A. BLACK (1934): An estimation of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Sci. 37*: 29-38.

YU RI QUING. G.Z. CHEN, Y.S. WONG, N.F.Y. TAM & C.Y. LAN (1997): Benthic macrofauna of the mangrove swamp treated with municipal water. *Hydrobiologia 347*: 127-137.